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Novel catalyst systems for deNO_x

David W. J. McClymont, Stan T. Kolaczowski, Kieran C. Molloy, Serpil Awdry
Centre for Sustainable Chemical Technologies, University of Bath, BA2 7AY, UK.

E-mail: D.W.J.McClymont@bath.ac.uk URL: <http://www.bath.ac.uk/csct>

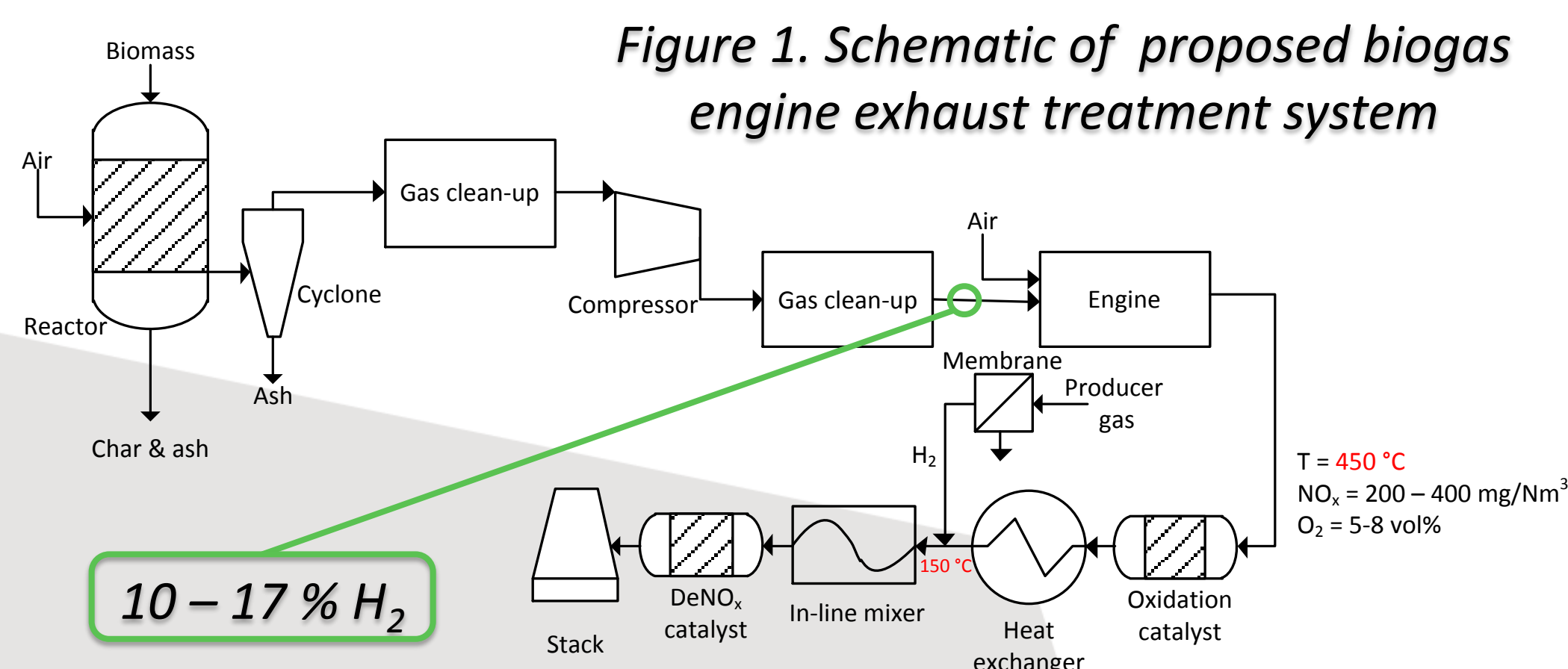


What is NO_x?

Nitric oxides are highly reactive gases; primarily NO (>90 %) and NO₂, involved in many pollutant processes *e.g.* the formation of acid rain

They are produced as a result of high temperatures during the combustion of fuels and legislation is in place to control emissions *i.e.* the European Waste Incineration Directive (WID) regulates activities that involve burning or gasification of waste (Figure 1)

Technologies have been developed which react a reductant with NO_x emissions, forming harmless N₂ and H₂O. Development of a material and process to treat NO_x emissions using H₂ is the aim of this project



H₂ for deNO_x

Measurements made on an operational gasification plant (Figure 2), using a mass spectrometer (Figure 5), identified the fuel produced as having a 10-17 % H₂ content depending on the conditions in the gasifier

Utilising H₂ already present in the system (Figure 1) can save on the associated costs of using additional chemicals, as in the current processes (*i.e.* NH₃ – selective catalytic reduction (SCR)) H₂ can also be used in NO_x storage and reduction (NSR) processes where NO_x species are 'trapped' before they are subsequently reduced through alternate lean and rich-burn cycles

Target chemistry : $2\text{NO} + 2\text{H}_2 \rightarrow 2\text{H}_2\text{O} + \text{N}_2$ $2\text{NO}_2 + 4\text{H}_2 \rightarrow 4\text{H}_2\text{O} + \text{N}_2$



Figure 2. Refgas gasification plant

Catalysts

Catalysts prepared using impregnation techniques (Table 1)

Supported on honeycomb monoliths (Figure 3)

Outer diameter = 14 mm

Channel size = 1 mm x 1 mm (~80 channels per monolith)

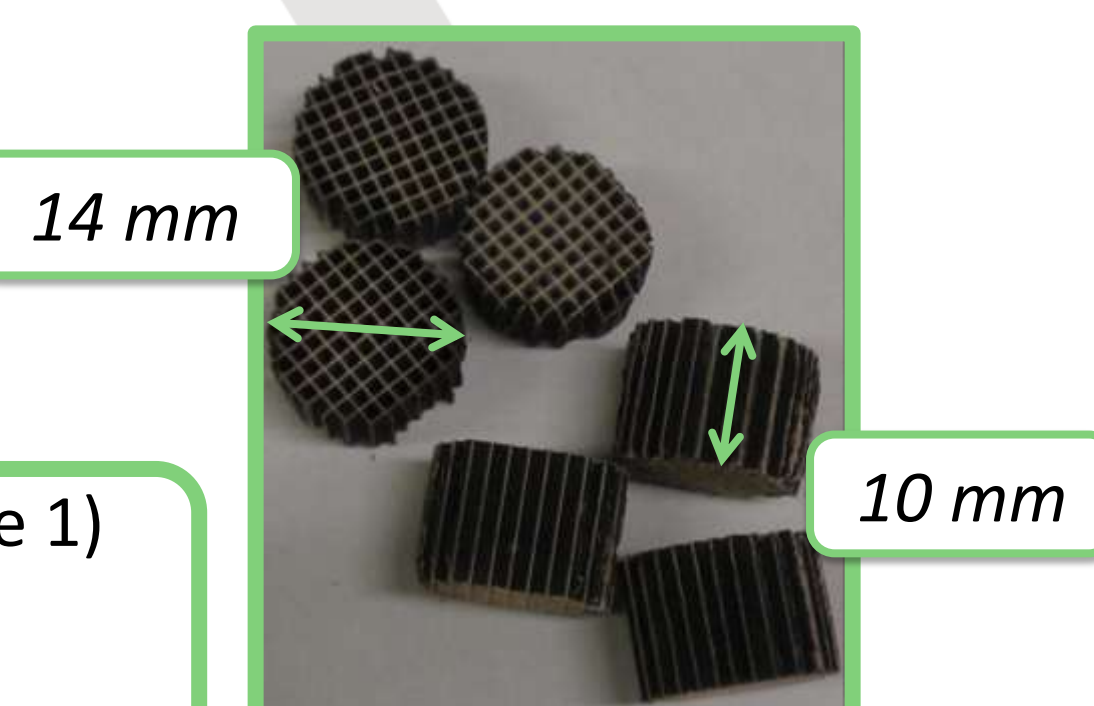


Figure 3. Pt/Al₂O₃ monoliths

Experimental set-up

A rig for investigating catalyst performance in the different processes has been designed, built and commissioned (Figure 4)

A method for identifying the products of the catalytic reactions, using an online mass spectrometer (Figure 5), has been developed and tested

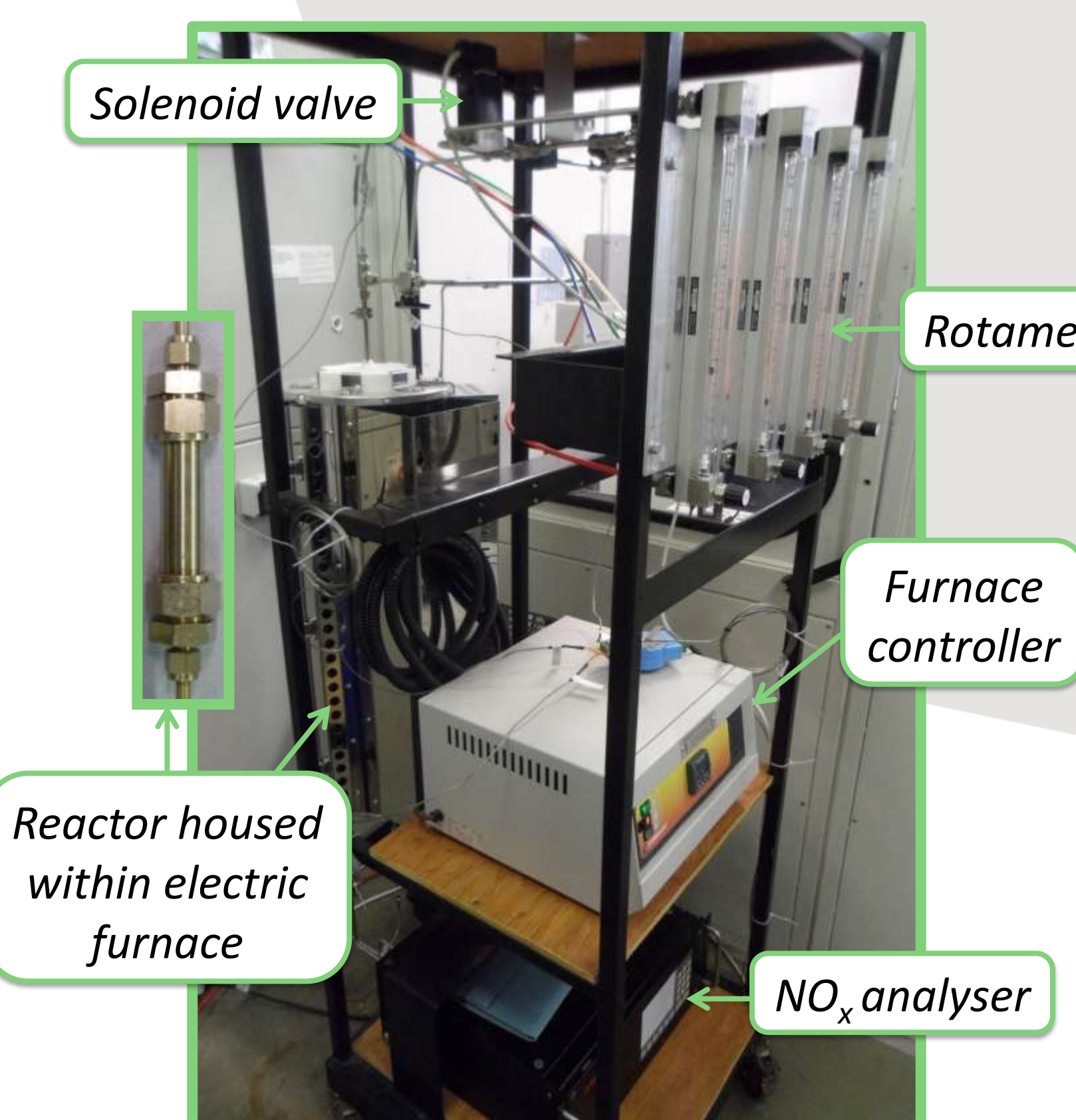


Figure 4. Experimental set-up

Table 1. Summary of prepared H₂-deNO_x catalysts and associated processes

H ₂ -SCR	H ₂ -NSR
Pt/Al ₂ O ₃	Pt/Ba/Al ₂ O ₃
Ag/Al ₂ O ₃	Pt/K/Al ₂ O ₃
	Ag/Ba/Al ₂ O ₃
	Ag/K/Al ₂ O ₃



Figure 5. Hidden mass spectrometer

Future work

Investigate prepared catalysts performance in their relevant processes and identify optimum conditions/limitations with relevance to the final application

Further characterize catalysts through temperature-programmed studies:

- Temperature-programmed desorption
- Temperature-programmed surface reactions

Investigate hybrid design; combination of both NSR and SCR processes, using H₂ as the reductant